Descriptions of the Pupae of Nine Genera of Australian Paropsine Chrysomelinae (Coleoptera: Chrysomelidae)

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The pupae of 18 species of 9 genera of Paropsina and Dicranosternina are described, including species of *Chrysophtharta* Weise, *Dicranosterna* Motschulsky, *Novacastria* Selman, *Paropsides* Motschulsky, *Paropsis* Olivier, *Paropsisterna* Motschulsky, *Pyrgoides* Aslam, *Trachymela* Weise and *Trochalodes* Weise. The contribution of pupal morphology to the interrelationships of these genera and to related Chrysomelinae is discussed. Pupal characters support discrimination of the subtribes Dicranosternina and Paropsina, established on adult characters.

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Introduction

The term paropsine is generally used in Australia to refer to members of two subtribes, Paropsina and Dicranosternina, of the leaf-beetle tribe Chrysomelini (Daccordi, 1982). Most paropsine genera are endemic to Australia, but *Paropsides* Motschulsky reaches China and Japan (Ohno, 1958) and other genera are present in New Guinea (Gressitt, 1963).

Paropsine larvae and adults are important pests of *Acacia* in Tasmania (Elliott and de Little, 1985), and plantation *Eucalyptus* in Australia (Greaves, 1966; Ohmart and Edwards, 1991) and abroad (Tribe and Cillie, 1985). The identification of paropsines represents a major problem for Australian insect ecologists because most genera are weakly defined. Adults of the Paropsina and Dicranosternina are defined by usually (!) having toothed claws and the edge of the elytral dorsal surface completely obscuring the epipleura in lateral view (Weise, 1915). Their larvae show similarities to *Gonioctena* (Gonioctenina; Takizawa, 1976) and their pupae have not been characterized. Studies of the phylogeny of the genera are confined to unpublished theses (de Little, 1979b; Reid, 1983; Daccordi, 1986). There are no recent published descriptions of the adults, except for revisions of the Tasmanian species of *Paropsis* (de Little, 1979a; Selman, 1983). Eggs and larvae are known to show good taxonomic characters at species level (Cumpston, 1939; de Little, 1979a,b; Reid, 1983; Selman, 1985) but pupae of Australian paropsines have only been superficially described (Cumpston, 1939). Here the pupae of nine genera, including the recently described paropsine-like *Novacastria* Selman (Selman and Lowman, 1983), are described and compared with other, non-paropsine, genera.

This study was undertaken to find pupal character states which may indicate relationships between genera or species groups of Paropsina and Dicranosternina and help clarify the position of *Novacastria*.

Materials and Methods

The pupae were associated with identifiable adults in three ways: by rearing from eggs laid by identified adults, by rearing other members of a larval population into

adults, or, in species with unusual hosts, by rearing from young larvae collected with adults. The sample described includes all such pupae in the Australian National Insect Collection (ANIC), CSIRO Division of Entomology, Canberra. The adults were determined by comparison with named material in the ANIC, or comparison with a colour photograph collection named by B. J. Selman, or from the published keys to species of *Pyrgoides* Aslam (Blackburn, 1897b, 1899, 1900). Plant hosts were identified using Costermans' (1981) guide to trees and shrubs. The specimens, fixed in KAA or 70% ethanol, were drawn with the aid of a drawing tube attached to a Wild M8 stereomicroscope. Fixing in KAA causes the elytra and wing thecae to spread out lateral to the body and the drawings have been made of this artificial state. All specimens are held in the ANIC unless otherwise indicated.

Descriptions of Pupae

Nomenclature for the setae has been partly modified from the curculionid system of May (1978), in which regions of the head and abdomen are named to distinguish what appear to be homologous groups of setae. Setal groups on the head are identified according to Fig. 2. The great variability in number and position of setae obviates the need to name each seta. Because of the prevalence of asymmetric variation, all counts of setae on the head and thoracic segments in the following descriptions refer to the setae on one side of a pupa only, unless otherwise specified. Numbers of setae in brackets represent unique scores in the larger samples. In the example given (Fig. 2) the setae are scored as follows: 1 upper vertex, 3-4 vertex, 1 ocular, 1 upper frons, 2 lateral frons, 0 inner frons. Short spine-like setae are referred to as spinulose. Each of abdominal segments I-VI may have one or two pairs of lateral knob-like or condyliform setose projections.

The pupae described here have the following combination of characters: *Body* closely resembling form of adult in size and shape, and proportion of cephalic and thoracic appendages (except wings). Colour usually yellow or orange, with characteristic pattern of setae. *Head* bent downwards so that mouthparts are directed posteriorly; antennae extend as far as mesothorax (terminating between front and mid-femora); labrum with 4 minute setae. *Legs* with subapical setae on femora. *Abdomen* with 9 movable segments, segments IX and X telescoped within segment VIII; tergite IX terminating in paired and adjacent, or fused, urogomphi (apical processes). *Spiracles* present on first 6 abdominal segments and well developed. *Sexual dimorphism.* There may be a small difference in size (♀ larger on average) but in most species the sexes differ only in the structure of the apical abdominal sternites (Reid and Ohmart, 1989). Sternite VIII of the ♀ is deeply divided in the large species, but only slightly grooved in the small species and therefore difficult to see. Sternite VIII of the ♂ is not grooved or divided. All species pupate in soil and have the long setae typical of this type of chrysomeline pupa (Paterson, 1931).

Key to Pupae of Paropsine Genera in Australia

1. Urogomphi, in dorsal view, widely separated and incurved at tip; 6 functional (well-developed) spiracles . . . . . (Phyllocharina; Reid 1991)
— Urogomphi, in dorsal view, fused into a single process, or narrowly separated and not incurved; 5 apparently functional spiracles 2
2(1). Urogomphi either separated or completely fused into a short blunt or slightly bifid process; sides of tergites without lateral tubercles and tergites without dense bands of setae . . . (Australian Gonioctenina; not treated further)

— Urogomphi either completely fused into a long sharply acute or deeply bifid process or dorsally fused but with each urogomphus distinguishable ventrally and apex of process deeply bifid; dense transverse bands of setae present if tergites with reduced lateral tubercles ..... (Paropsina and Dicranosternina) 3

3(2). Abdominal tergites I-VI with two pairs of condyliform tubercles, at lateral margin and posterior to spiracle (Figs 1, 11); lateral tubercles of tergite VI with >10 setae; apical margin of sternite VII thickened and spinulose (Figs 3, 13) (size >5 mm; apex of urogomphus bifid) 4

— Abdominal tergites I-VI with only a pair of simple or condyliform lateral tubercles; lateral tubercles of tergite VI with <10 setae; apical margin of sternite VII not thickened, rarely spinulose 5

4(3). Abdominal tergites between spiracular tubercles with two pairs of setal patches, central tergal setae therefore in longitudinal rows (Fig. 11); outer patch of setae on a tubercle on tergites II-V; >10 vertical setae, each side; apices of femora with 3 setae ..... *Paropsisterna*

— Abdominal tergites with central setae in an irregular lateral row, without additional tubercles (Fig. 1); <10 vertical setae, each side; apices of femora with at least 4 setae ..... *Paropsis*

5(3). Metanotal and tergal setae in dense transverse bands (Figs 26, 31); lateral tergal tubercles feebly developed (length >8.5 mm; apex of urogomphus bifid) 6

— Metanotal and tergal setae scattered or in irregular single rows (Figs 4, 14); lateral tubercles more strongly developed 7

6(5). Dorsal setae set on small tubercles (Fig. 31); apex of tibia without setae; upper vertex with >5 setae each side (Fig. 32) ..... *Trochalodes*

— Dorsal setae simple (Fig. 26); apex of tibia setose (Fig. 28); upper vertex with 1 seta each side (Fig. 27) ..... *Dicranosterna*

7(5). Apex of urogomphus bifid (Figs 4, 14); size larger, >5 mm 8

— Apex of urogomphus acutely pointed (Figs 18, 34); size smaller, <5 mm 11

8(7). Pronotum with >80 relatively short setae (Fig. 4); lateral tubercles condyliform, mostly with >3 setae 9

— Pronotum with <70 long setae (Fig. 14); lateral tubercles simple, with 2-3 setae 10

9(8). >2 vertical and <3 upper vertical setae each side (Fig. 5) ..... *Chrysophtharta*

— 2 vertical and >3 upper vertical setae each side (Figs 23-24) ..... *Trachymela*

10(8). Apex of sternites VII and VIII with sclerotized spinules (Figs 9-10); tergite VI with >15 setae between spiracles (Fig. 7) ..... *Paropsides*

— Apex of sternites VII and VIII simple (Figs 16-17); tergite VI with <15 setae between spiracles (Fig. 14) ..... *Pyrgoides* partim (*rubiginosa*)

11(7). Meso- and metanotum each with 4 setae (Fig. 18); tergites I-VI with 6 setae between spiracles; upper vertex setae absent (Fig. 19) ..... *Pyrgoides* partim (*hamadryas* and allies)

— Mesonotum with 3-5 setae, metanotum with 5-7 setae (Fig. 34); tergites I-VI with 6-12 setae between spiracles; 1-2 upper vertex setae (Fig. 35) ..... *Novacastria*

Species Descriptions

Remarks: The pupa of the type species of *Paropsis*, *P. atomaria* Olivier, is described first. Full descriptions are given of *P. atomaria*, *Chrysophtharta* sp. nr *amoena* (Clark), *Pyrgoides*

TABLE 1

Summary of lengths (in mm.) and setal scores (all other figures) for pupae of Paropsina and Dicranosternina. Chry = Chrysophtharta; *Pard* = Paropsides; *Parp* = Paropsis; *Parn* = Paropsisterna; *Pyrh* = Pyrgoides hamadryas *and allies; Pyrr* = Pyrgoides rubiginosa; *Trac* = Trachymela; *Nova* = Novacastria; *Dicr* = Dicranosterna; *Troc* = Trochalodes. *Number in brackets is number of species. Number in brackets after femoral score is modal value.*

	Chry (2)	Pard (1)	Parp (4)	Parn (2)	Pyrh (3)	Pyrr (1)	Trac (1)	Nova (1)	Dicr (1)	Troc (1)
Length (mm.)	6.3-9.4	5.8-6.4	9.8-16.3	12.0	3.2-5.0	5.9-6.4	10.2-11.0	4.2-4.4	13.0-14.8	8.6-8.7
HEAD										
Upper vertex	0-2	1	0-1	3-4	0	0	4-6	1-2	1-2	6-9
Vertex	3-7	2-3	3-9	11-20	2	2	2	2	2-4	5-7
Upper frons	1	1	1-2	2-5	0-1	0-1	0-1	0-1	0-2	2-3
Ocular	1	1	1-4	1-5	1	1	1-2	1	1-3	1-2
Lateral frons	2	2	2-3	2	0-2	2-3	1-2	2	3-8	2-3
Inner frons	0	0	0-1	0	0	0	0 -1	0	0 -1	2-3
PRONOTUM	80-105	75-90	90-120	100-110	16-21	25-32	100-120	25-31	125-145	100-110
MESONOTUM	4-8	2-6	5-15	19-26	2	2-3	7-9	3-5	3-10	7-18
METANOTUM	4-12	4-6	6-16	18-28	1-2	2-4	9-13	5-7	25-33	21-31
LEGS										
Femur	0-4 (4)	0-3 (3)	4-7 (5)	3	3	3	3-4 (3)	3	8-14	2-6 (4)
Tibia	0	0	0	0	0	0	0	0	1-3	0
TERGITE I										
Central	2-8	3-6	10-17	4-20	2	2-5	11-12	2-5	22-40	
Spiracular	1-3	1-2	3-6	5-13	1	1		1-2	2-8	17-22
Lateral	0-4	2	5-8	8-11	1	2-3	3-5	1-2	4-7	1-2
TERGITE VI										
Central	5-12	6	14-24	21-29	2	2-5	16-20	2-5	27-36	
Spiracular	1-4	1-2	6-12	15-17	1	1-2		1-2	4-9	22-36
Lateral	1-9	2-3	14-20	12-25	2	2-3	4-8	1-2	5-8	2-7
TERGITE VII										
Central + spir.	16-27	6-8	29-37				17-21			34-42
Lateral	1-8	3	8-14	35-49	2-3	6-7	6-8	5-6	28-42	1-3
TERGITE VIII	4-13	6-10	17-25	27-32	3	3-4	11-12	4-5	18-28	17-23

rubiginosa (Chapuis), *Trachymela* sp. nr *tincticollis* (Blackburn) and *Dicranosterna immaculata* Motschulsky, and the other species are compared with these. At least one species of each genus is illustrated. The distributions of setae and measurements of all species in each genus are summarized in Table 1. Colour of the living pupa is various shades of yellow, with brown setae.

SUBTRIBE PAROPSINA Motschulsky, 1860

Paropsis Olivier, 1807

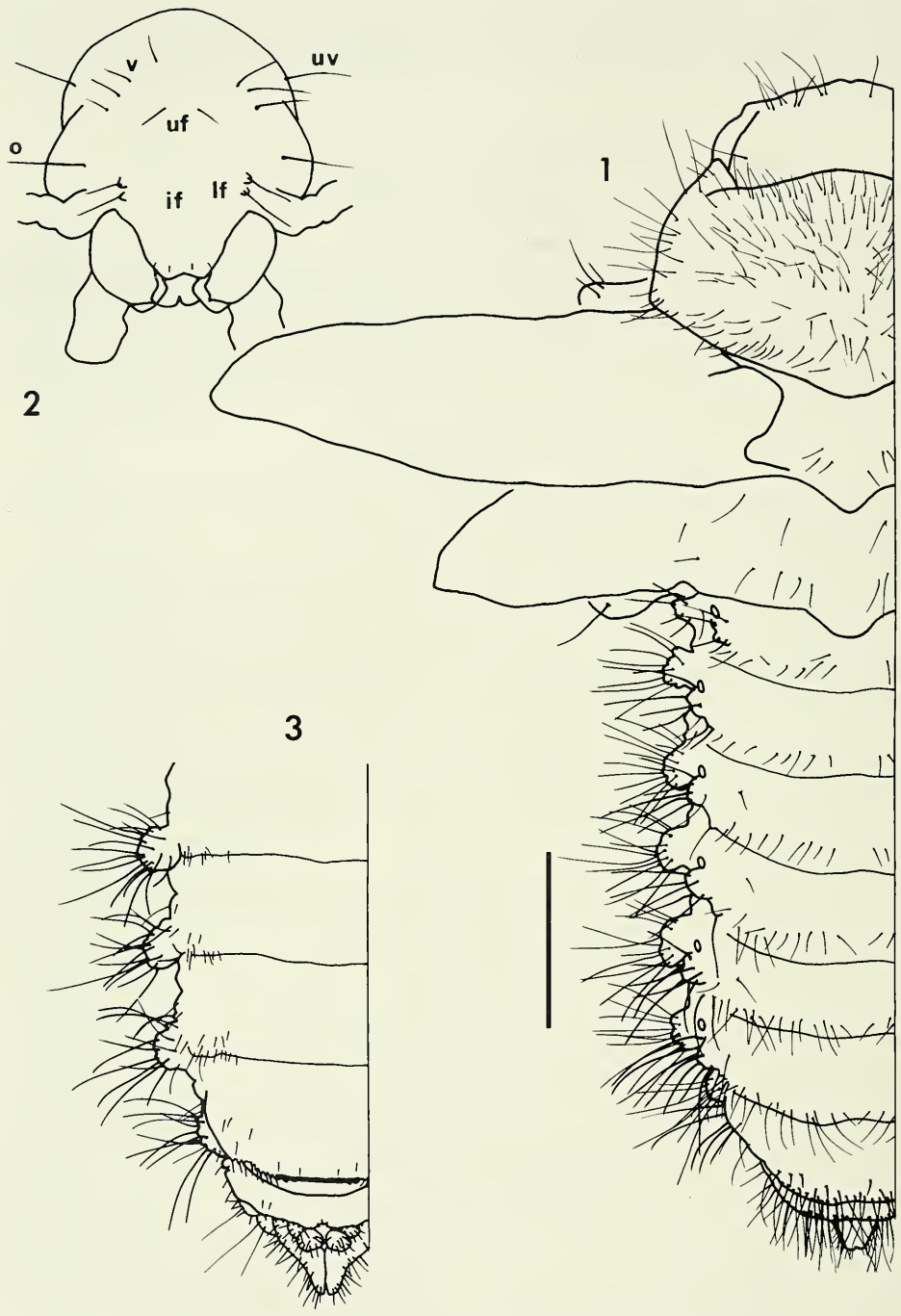
Type species: *Paropsis atomaria* Olivier (Selman, 1963)

Diagnosis: Pupae of *Paropsis* may be distinguished from all other genera except *Paropsisterna* by the possession of strongly developed spiracular tubercles, patches of small setae at the sides of sternite VI, and the strongly sclerotized apex of sternite VII. Pupae of *Paropsis* may be separated from those of *Paropsisterna* by the fewer setae on the vertex and metanotum, the transverse band of central abdominal setae, the fewer apical spinuliform setae on sternite VII and the presence of 4-7 subapical setae on each femur.

Paropsis atomaria Olivier, 1807
(Figs 1-3)

Material examined: AUSTRALIAN CAPITAL TERRITORY: 10♂ 10♀, ex culture, originally collected Canberra, 1984, C. P. Ohmart.

Description: *Measurements* (mm.): length, ♂ 13.2-15.3, ♀13.4-16.3; head width, ♂ 2.8-3.3, ♀3.0-3.6; pronotal width, ♂ 4.6-5.3, ♀4.7-5.5. *Head.* Setae: (0)-1 upper vertex, 3-9 vertex, 1-(2) ocular, 1-(2) upper frons, 2-(3) lateral frons. Mandibular thecae conspicuously toothed. *Thorax.* Pronotum with 90-110 scattered setae, greatest density in anterior half, near midline. Mesonotum: setae in 2 groups, outer 1-3, inner 4-12. Metanotum: 6-16, scattered in transverse row, or almost in 2 or 3 groups. Legs: each femur with 4-7 preapical setae, 5 most frequent (64%). *Abdomen* (see Reid and Ohmart, 1988, figs 1-2): tergites I-VI with irregular transverse row of setae along posterior margin (central setae) increasing from 10-17 each side on tergite I, to 14-24 on tergite VI; usually 1-2 small, subsidiary setae on each side of tergites I-VII, anterior to central row; tergites I-VI with two setose globular prominences, lateral to central row, smaller one posterior to spiracle (spiracular tubercle), larger on posterior half of lateral margin (lateral tubercle); spiracular tubercle small with 3-6 setae on tergite I, larger with 6-12 setae on tergites II-VI; lateral tubercle small with 5-8 setae on tergite I, larger with 14-20 setae on tergites II-VI; tergite VII central and spiracular tubercle setae merged, 29-37, lateral tubercle reduced, 8-14; tergite VIII without obvious tubercles, largely enclosed within tergite VII, 17-25; tergite IX projecting from within tergite VIII as a blunt posterio-dorsally directed process with a bifid sclerotized apex; sternites II-VI with a scattered patch of small setae on posterior margin near lateral tubercle, otherwise glabrous; posterior margin of sternite VII thickened centrally into a dark brown ridge, with 7-13 dark brown spinuliform setae (actually very short setae on sclerotized conical tubercles) between this and lateral margin; sternite VIII of ♂ with a small incision on posterior margin and 14-23 dark brown spinuliform setae each side of margin; sternite VIII of ♀ deeply cleft along midline from base to apex, with 11-15 dark brown marginal spinuliform setae each side; venter of tergite IX represented by 2 brown sclerotized lobes with sinuate lateral margins, the lobes contiguous from hemitergites X to their apices, with many short setulose setae; sternite IX divided, lobes ovate, separated by their diameter in ♂, lobes transverse, contiguous in ♀; tergite X divided, lobes ovate, contiguous in both sexes; lobes of sternites IX and X with scattered spinulose setae; spiracles distinct, dark brown and sclerotized, slightly raised, on tergites I-V, small, pale and presumably functionless on tergite VI.



Figs 1-3. ⊙*Paropsis atomaria.* **1**, left side, dorsal (lateral tubercle setae omitted). **2**, head, anterior; setae; lf = lateral frons, if = inner frons, o = ocular, uv = upper vertex, uf = upper fronts, v = vertex. **3**, right side abdomen, ventral. Scale = 2mm.

Paropsis obsoleta Olivier, 1807

Material examined: AUSTRALIAN CAPITAL TERRITORY: 1♂, 2♀, Canberra, reared from adults, i.1974, C. P. Whittle.

Description: similar to *P. atomaria*, setal pattern apparently differing only in ocular setae. Only the head setae are described here as the setae of the pronotum, mesonotum, abdomen (including sexual structures) and legs are all within the range of *P. atomaria*. The spinuliform setae and their tubercles are pale and inconspicuous on sternites VII and VIII, but this may be due to bleaching. *Measurements* (mm.): length, ♂ 9.8, ♀ 10.1 mm; head width, ♂2.7, ♀3.1; pronotal width, ♂4.2, ♀4.5. *Head setae:* 1 upper vertex, 3-8 vertex, 2-3 ocular, 1 upper frons, 2-3 lateral frons.

Paropsis porosa Erichson, 1842

Material examined: 1♂, unprovenanced material in vial with larvae and adults (ex Carne).

Description: similar to *P. atomaria*, setal pattern different on meso- and metanotum and with more head setae. Pronotum as *P. atomaria*. Mesonotum and metanotum with setae more or less in 3 groups. Abdomen and legs as *P. atomaria*. *Measurements* (mm.): length (slightly shrivelled) 10.3; head width 2.5; pronotal width 4. *Head setae:* 1 upper vertex, 7-9 vertex, 2-4 ocular, 1-2 upper frons, 2 lateral frons, 1 inner frons.

Paropsis sp. nr. *bella* Blackburn, 1894

Material examined: AUSTRALIAN CAPITAL TERRITORY: 2♂, 1♀, Canberra, reared from adults, 9.ix.1975, C. P. Whittle.

Description: similar to *P. atomaria*, no setal differences detected, except more, denser pronotal setae (c120 each side). *Measurements* (mm.): length, ♂12.1, ♀14.3; head width, ♂2.7, ♀3.0; pronotal width, ♂4.3, ♀4.7. *Head setae:* 1 upper vertex, 3-5 vertex, 1 ocular, 1 upper frons, 2 lateral frons, 0-(1) inner frons.

Chrysophtharta Weise, 1901

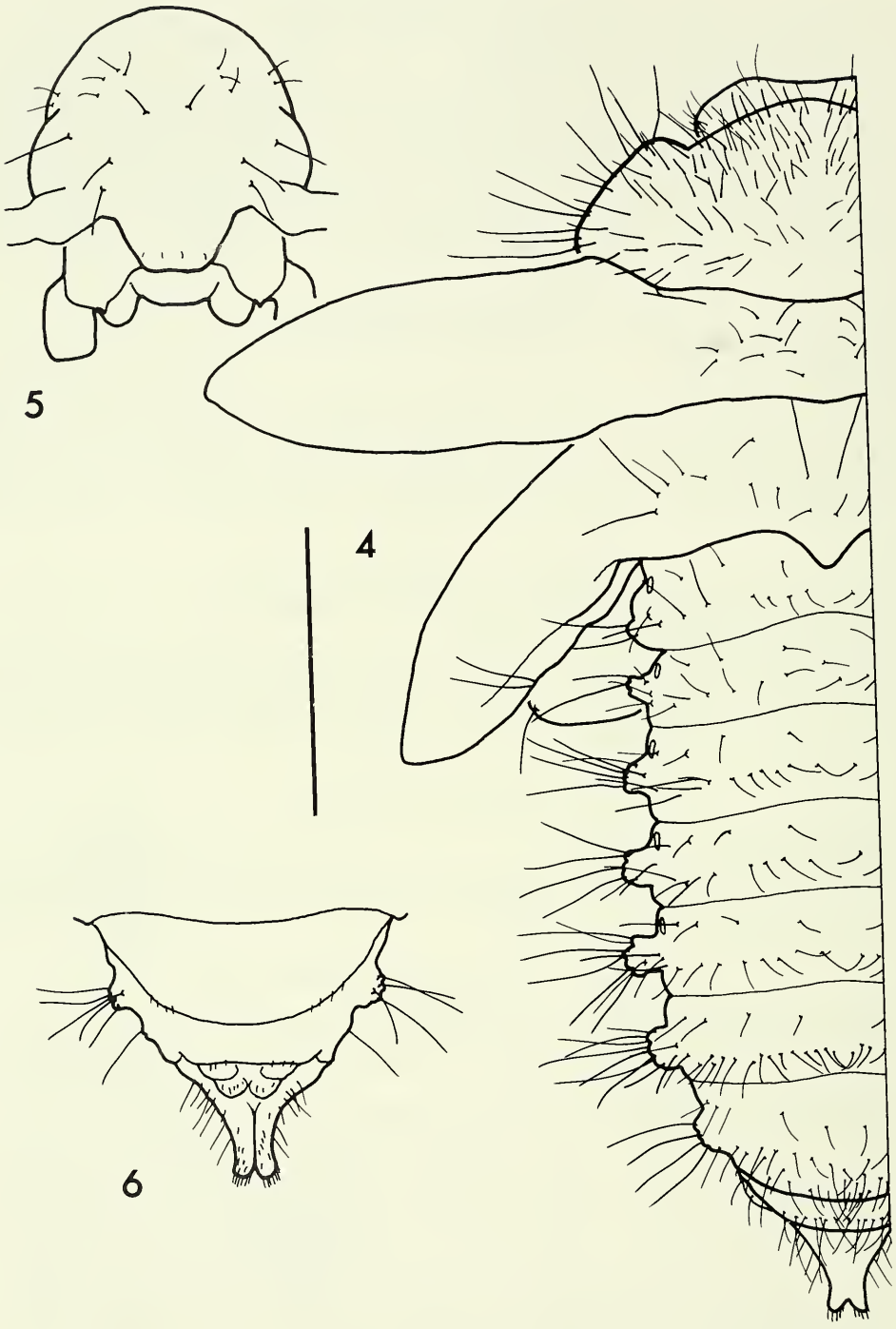
Type species: not designated

Diagnosis: Pupae of *Chrysophtharta* may be distinguished by the lack of spiracular tubercles, and the presence of moderately setose lateral tubercles, less than 3 upper vertex setae and more than 2 vertex setae.

Chrysophtharta sp. nr *inconstans* (Blackburn, 1900)
(Figs 4-6)

Material examined: AUSTRALIAN CAPITAL TERRITORY: 2♂, 4♀, Shepherd's Lookout, Murrumbidgee R., ex larvae on *Eucalyptus polyanthemos*, 26.xi.1989, C. Reid; pupated 3-5.xii. 1989, 3 adults reared.

Description: *Measurements* (mm.): length, ♂8.6-8.8, ♀8.6-9.4; head width, ♂1.8-1.9, ♀1.9-2.0; pronotal width, ♂3.2-3.3, ♀3.2-3.4. *Head.* Setae: 2 upper vertex, (3)-(7) vertex, 1 ocular, 1 upper frons, 2 lateral frons. Mandibular thecae conspicuously toothed. *Thorax.* Pronotum with 80-95 setae, scattered but more dense towards front and side margins. Mesonotum: 5-8 setae, sometimes in two groups, with 1-2 subsidiary anterior setae. Metanotum: 7-(12) setae in scattered row or two groups plus 1-2 subsidiary anterior setae. Legs: apex of each femur with 3-4 setae, 4 most frequent (97%). *Abdomen:* tergites I-VI with irregular transverse row of setae along posterior margin (central setae) increasing from 5-(8) each side on tergite I, to (7)-12 on tergite VI; 2-5 small, subsidiary setae on each side of tergites I-VII, anterior to central row; spiracular setae on small tubercles, (1)-(3) setae on tergite I, 2-3 setae on tergites II-VI; lateral



Figs. 4-6. ♂ *Chrysophtharta* sp. nr *inconstans.* **4**, left side, dorsal. **5**, head, anterior. **6**, apex abdomen, ventral. Scale = 2 mm.

tubercles of tergites II-VI condyliform, small with 1-(4) setae on tergite I, larger with 5-9 setae on tergites II-VI; tergite VII central and spiracular tubercle setae merged, 22-27, lateral tubercle (5)-8; tergite VIII without obvious tubercles, largely enclosed within tergite VII, 8-(13); tergite IX projecting from within tergite VIII as a posterio-dorsally directed process with a bifid sclerotized apex; sternites IV-VI with 1-2 small setae on posterior margin near lateral tubercle, otherwise glabrous; posterior margin of sternite VII simple, with 3-8 inconspicuous setae each side; sternite VIII of ♂ with straight posterior margin and 5-6 short setae each side of margin; sternite VIII of ♀ deeply emarginate and divided along midline, 3-6 short setae each side; venter of tergite IX represented by 2 lobes sclerotized at tips with sinuate lateral margins, the lobes contiguous from hemitergites X to their apices, with many short setae; sternite IX divided, lobes ovate, separated by their diameter in ♂, lobes transverse, almost contiguous in ♀, tergite X divided, lobes ovate, almost contiguous in both sexes; spiracles dark brown and sclerotized on tergites I-V, not visible on tergite VI.

Chrysophtharta sp. nr *amoena* (Clark, 1865)

Material examined: NEW SOUTH WALES: 3♂, 3♀, reared from adults collected at Mill Post, 8 km. sw. Bungendore, P. Edwards.

Description: similar to *C.* nr *inconstans*, except slightly less setose, especially on the thoracic and abdominal tergites. The lateral tubercles are also slightly less prominent. *Measurements* (mm.): length, ♂6.3-7.2, ♀7.3-8.3; head width, ♂1.9-2.2, ♀2.1-2.3; pronotal width, ♂2.7-3.1, ♀3.2-3.7. *Head.* Setae: 0-2 upper vertex, 3-5 vertex, 1 ocular, 1 upper frons, 2 lateral frons. Mandibular thecae conspicuously toothed. *Thorax.* Pronotum: 80-105 setae, scattered but more dense towards front and side margins. Mesonotum: 4-(8) setae, in roughly two groups, outer 1-3, inner (2)-(6). Metanotum: (4)-(8) setae in scattered row or two groups. Legs: apex of each femur with 0-4 setae, 4 most frequent (62%). *Abdomen:* tergites I-VI with irregular transverse row of setae increasing from (2)-5 each side on tergite I, to (5)-(10) on tergite VI; 0-4 small, subsidiary setae on each side of tergites I-VII, anterior to central row; spiracular setae on small tubercles, 1-2 setae on tergite I, 1-4 setae on tergites II-VI; lateral tubercle small with (0)-2 setae on tergite I, larger and condyliform with (1)-7 setae on tergites II-VI; tergite VII central and spiracular tubercle setae merged, 16-(25), lateral tubercle reduced, (1)-6; posterior margin of sternite VII simple, with 2-5 inconspicuous setae each side; sternite VIII of ♂ with simple posterior margin and 3-5 short spinulose setae each side of margin; sternite VIII of ♀ deeply cleft along midline from base to apex, 3-5 short spinulose setae each side; spiracles dark brown and sclerotized on tergites I-V, small, pale and presumably functionless on tergite VI.

Paropsides Motschulsky, 1860

Type species: *Paropsis duodecimpustulata* Gebler, by original designation (Motschulsky, 1860)

Diagnosis: Pupae of *Paropsides* may be distinguished by the combination of weak lateral tubercles with 2-3 setae, 75+ pronotal setae, and a bifid urogomphus.

Paropsides umbrosa (Chapuis, 1877)
(Figs 7-10)

Material examined: AUSTRALIAN CAPITAL TERRITORY: 5♂, 6♀, Black Mountain, ex larvae with adults of *P. umbrosa* on *Daviesia retorta*, 29.vii.1989, C. Reid; pupated 20-30.viii. 1989.

Description: *Measurements* (mm.): length, ♂5.8-6.3, ♀6.0-6.4; head width, ♂1.4-1.5, ♀1.5-1.7; pronotal width, ♂2.2-2.5, ♀2.3-2.5. *Head.* Setae: 1 upper vertex, 2-3 vertex, 1

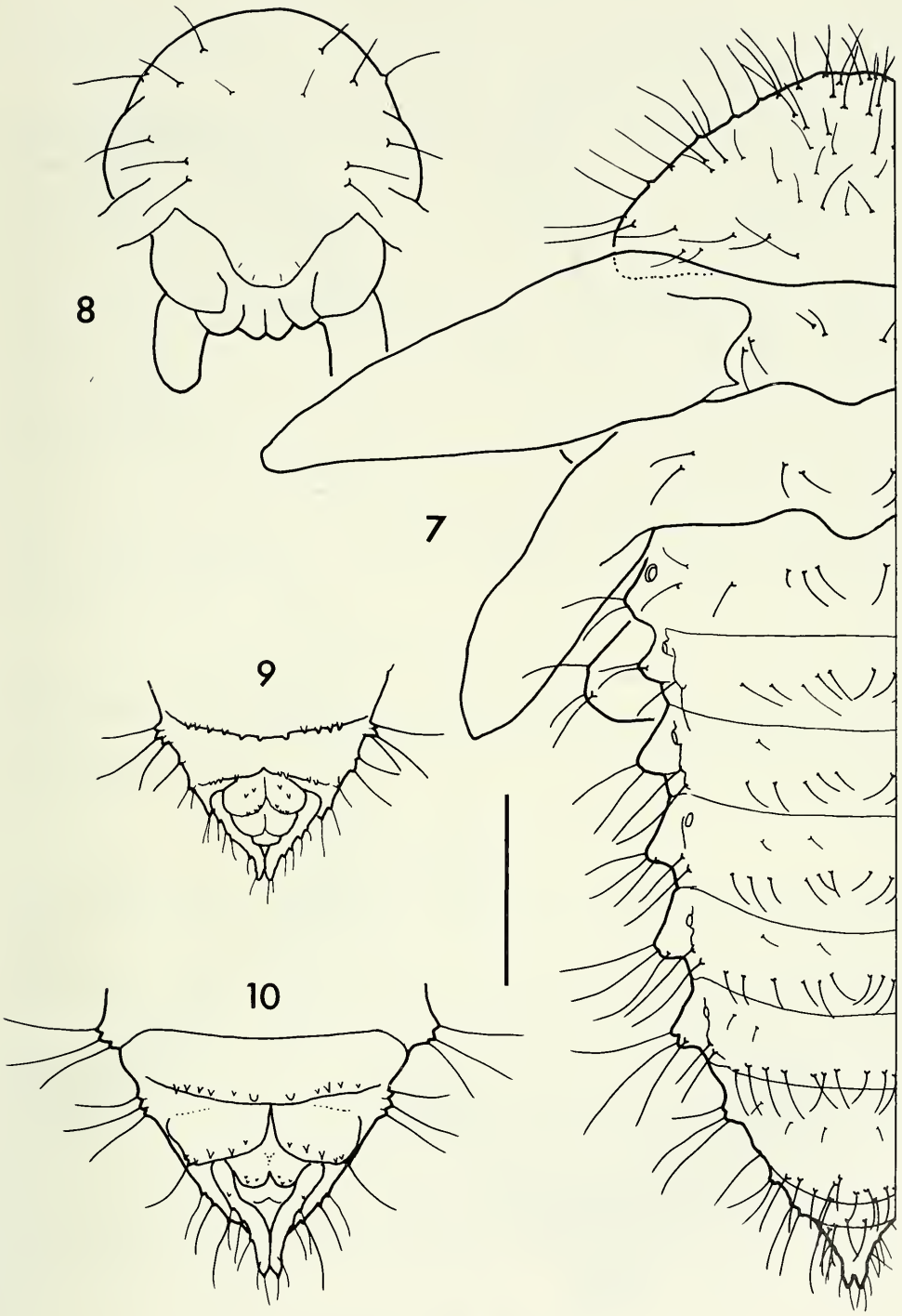
ocular, 1 upper frons, 2 lateral frons. *Thorax.* Pronotum: 75-90 setae, scattered but more dense towards middle. Mesonotum: setae in two groups, outer (1)-2, inner 1-(4). Metanotum: setae in two groups, outer 2-3, inner 2-3. Legs: apex of each femur with 0-3 setae, 3 most frequent (95%). *Abdomen:* tergites I-VI with irregular transverse central row of setae along posterior margin (central setae) increasing from 3-6 (usually 4) each side on tergite I, to 6 on tergite VI; 0-3 small, subsidiary setae on each side of tergites I-VII, anterior to central row; tergites without condyliform tubercles; 1-2 spiracular setae on tergites I-VI; lateral tubercle small with 2 setae on tergite I, larger with 2-3 setae on tergites II-VI; tergite VII combined central and spiracular setae 6-8, lateral tubercle reduced, 3; tergite VIII largely enclosed within tergite VII, (4)-7, lateral tubercle 2-3; tergite IX projecting from within tergite VIII as a posterio-dorsally directed process with a bifid sclerotized apex; sternites II-IV glabrous, V with 2 small lateral setae, VI with 0-3 small lateral spinules; posterior margin of sternite VII with (4)-(8) dark brown spinuliform setae (actually very short setae on sclerotized conical tubercles) on either side; sternite VIII of ♂ with a shallow median incision and 4-6 dark brown spinuliform setae each side of margin; sternite VIII of ♀ divided along midline from base to apex, with (0)-5 dark brown marginal spiniform setae each side; venter of tergite IX represented by 2 brown sclerotized lobes with sinuate lateral margins, the lobes contiguous for most of their length, with spinules and short setae; separate lobes of sternites IX adjacent in both sexes, with scattered small spiniform setae; spiracles dark brown and sclerotized on tergites I-V, not visible on tergite VI.

Paropsisterna Motschulsky, 1860

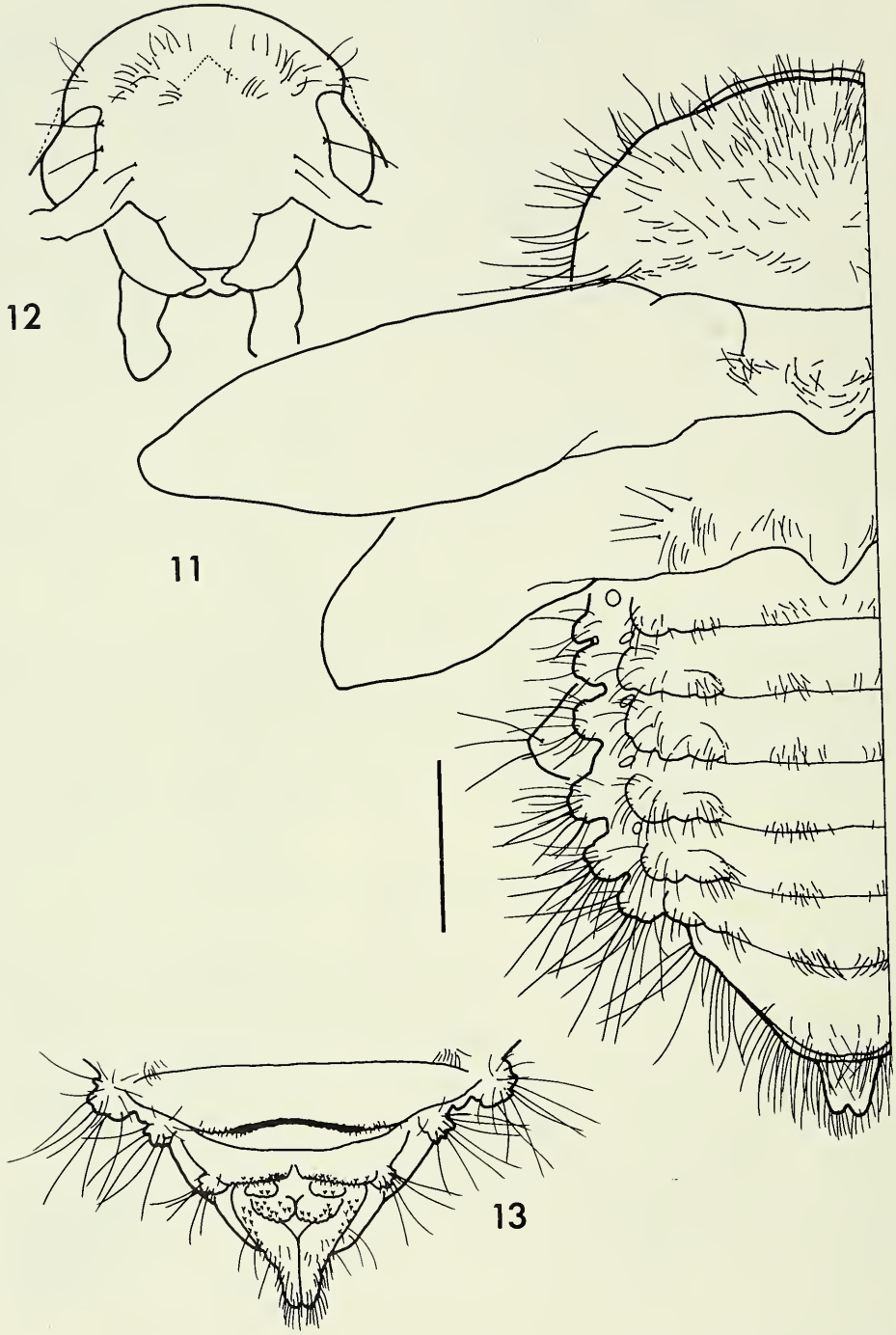
Type species: *Paropsisterna sexpustulata* Motschulsky, by original designation
Diagnosis: Pupae of *Paropsisterna* may be distinguished from all others except *Paropsis* by the possession of strongly developed spiracular tubercles, patches of small setae at the sides of sternite VI, and the strongly sclerotized apex of sternite VII. Pupae of *Paropsisterna* may be separated from those of *Paropsis* by the greater number of setae on the vertex and metanotum, the division of central abdominal setae into 2 groups, the greater number of apical spinuliform setae on sternite VII and the presence of only 3 subapical setae on each femur.

Paropsisterna beata (Newman, 1842)
(Figs 11-13)

Material examined: AUSTRALIAN CAPITAL TERRITORY: 1 ♀, Glendale Crossing, reared from adult on eucalypt, eggs laid 13.i.1987, hatched 20.i.1987, pupated 12.ii.1987, C. Reid; 1 ♀, Black Mountain, eggs laid 9.ii.1966, hatched 14.ii.1966, prepupa 4.iii.1966; pupated 7.iii.1966, B. Musik.
Description: *Measurements* (mm.): length 12; head width 3; pronotal width 4.6-4.9. *Head.* Setae: 3-4 upper vertex, 11-20 vertex, 1-4 ocular, 2-5 upper frons, 2 lateral frons. *Thorax.* Pronotum: 110 setae, especially on apical half of disc. Mesonotum: setae in two groups, outer 10-14, inner 9-12. Metanotum: setae in two groups, outer 14-17, inner 9-11. Legs: all femora with 3 preapical setae. *Abdomen:* tergites I-VI with 2 groups of central setae along posterior margin, between spiracular tubercle and midline, outer group on small tubercle; no subsidiary setae in apical half; outer group increasing from 5-7 on tergite I to 9-13 on tergite VI; inner group 11-15 on tergites I-VI; spiracular and lateral tubercles well-developed, condyliform, with long setae; spiracular tubercle with 10-12 setae on tergite I to 15-16 on tergite VI; lateral tubercles with 8-11 on tergite I and 12-17 on tergites II-VI; tergite VII with 35-37 setae each side; tergite VIII with 27-28 setae each side; sternite VII with 21-23 spinuliform setae each side, evenly spaced across posterior margin including ridge; sternite VIII as ♀ *P. atomaria* except 28-30 spinuliform setae



Figs. 7-10. ♂ *Paropsides umbrosa.* **7**, left side, dorsal. **8**, head, anterior. **9**, apex abdomen, ventral. **10**, ♀, apex abdomen, ventral. Scale = 1 mm.



Figs. 11-13. ♂ *Paropsisterna beata.* **11**, left side, dorsal. **12**, head, anterior. **13**, apex abdomen, ventral. Scale = 2 mm.

each side, these larger than in *Paropsis* spp.; segments IX and X as ♀ *P. atomaria*. Spiracles as *P. atomaria*.

Paropsisterna sexpustulata (Marsham, 1808)

Material examined: QUEENSLAND: 1♂, Brisbane, reared from adults on *Eucalyptus*, iv-vi. 1978, K. Houston (Department of Primary Industries, Indooroopilly, Queensland).

Description: similar to *P. beata*, with only small differences in the numbers of setae. *Measurements* (mm.): body length not measured due to shrinkage; head width 3.0; pronotal width 4.7. *Head.* Setae: 4 upper vertex, 16-17 vertex, 4-5 ocular, 2-3 upper frons, 2 lateral frons. *Thorax.* Pronotum: 100 setae, distributed as *P. beata.* Mesonotum: setae in 2 groups, outer 8-9, inner 13. Metanotum: setae in 2 groups, outer 9-13, inner 9-11. Legs: all femora with 3 preapical setae. *Abdomen:* tergites I-VI with 2 groups of setae as *P. beata*; outer group increasing from 2-3 on tergite I to 11-14 on tergite VI; inner group increasing from 2-3 on tergite I to 10-15 on tergite VI; no subsidiary setae on apical half; spiracular and lateral tubercles as *P. beata*; spiracular tubercle with 5-7 setae on tergite I, increasing to 16-17 on tergite VI; lateral tubercle with 8-10 setae, segment I, and 17-25 setae segs. II-VI; tergite VII with 46-49 setae; tergite VIII with 27-32 setae; tergite IX and sternites II-VI as *P. beata*; sternite VII with 6 spinuliform setae between ridge and lateral margin, and ridge with 25 minute spinuliform setae along posterior margin; sternite VIII with 26 spinuliform setae each side; segments IX and X and spiracles as *P. beata.*

Pyrgoides Aslam, 1968

Type species: not designated

Diagnosis: Pupae of *Pyrgoides* may be distinguished by ventrally fused urogomphi, lack of upper vertical setae, less than 5 metanotal setae and weakly developed lateral tubercles with 1-3 setae.

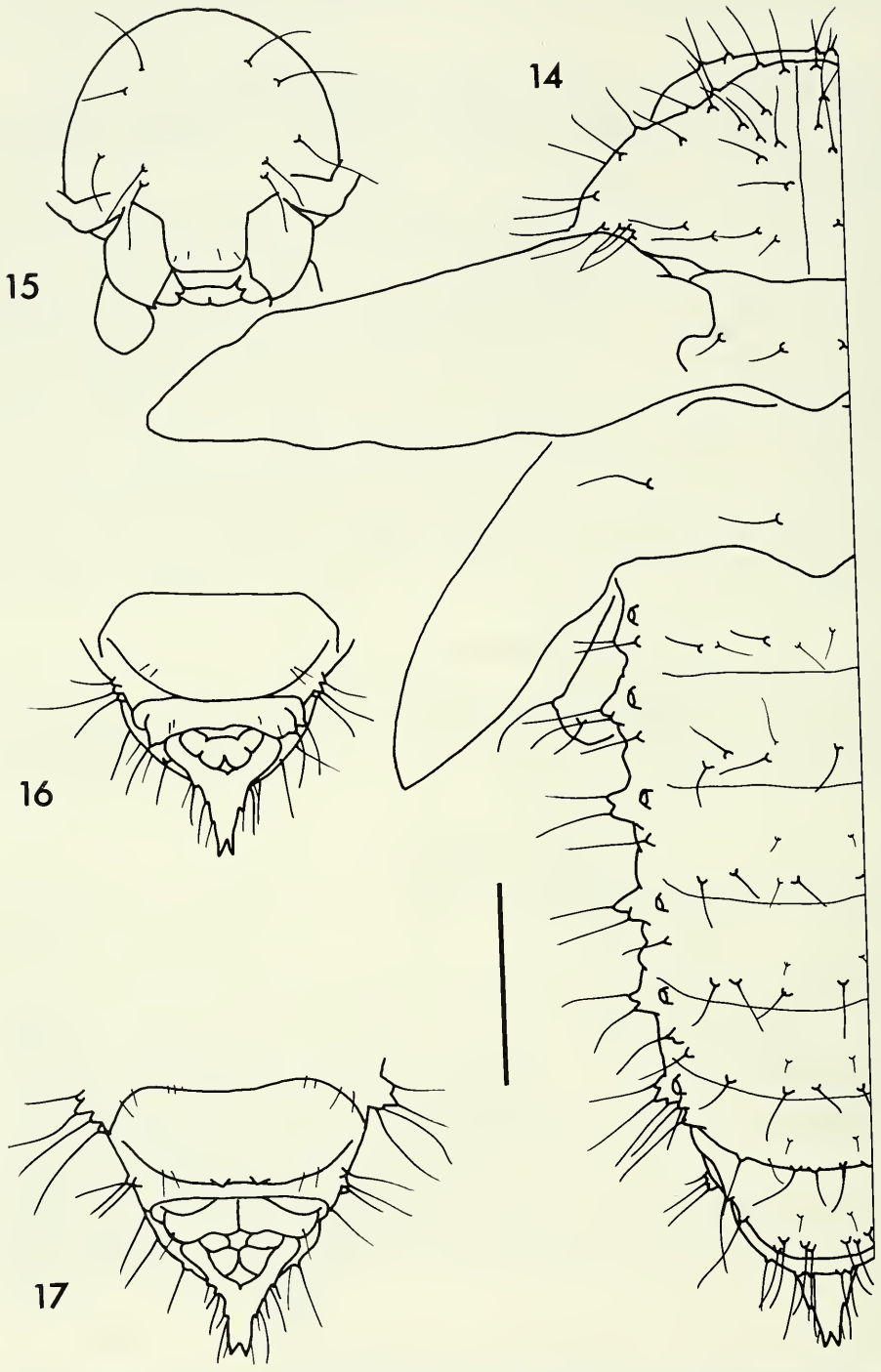
Pyrgoides rubiginosa (Chapuis, 1877)
(Figs 14-17)

Material examined: NEW SOUTH WALES: 2♂, 1♀, Temora, reared from larvae and adults on *Acacia hakeoides* flowers, collected 20.viii.1985, pupated 30.viii.1985, C. Reid.

Description: *Measurements* (mm.): length 5.9-6.4; head width 1.2-1.4; pronotal width 2.1-2.2. *Head.* Setae: 2 vertex, 1 ocular, 2-3 lateral frons, 0-1 upper frons. Mandibular thecae toothed. *Thorax.* Pronotum: 25-32 setae, distributed submarginally and near the midline. Mesonotum: 2-3 setae. Metanotum: 2-4 setae. Legs: all femora with 3 preapical setae. *Abdomen:* each of tergites I-VI with (2)-5 central setae each side, and frequently a small subsidiary seta anterior to these, 1-2 spiracular setae (only 1 on tergite I), and 2-3 setae on lateral tubercle; tergite VII with 6-7 marginal setae plus 1 subsidiary; tergite VIII 3-4; tergite IX represented by an elongate projection, bifid and sclerotized at tip; apical sternites with few minute marginal setae, without spinuliform setae; sternite VIII medially longitudinally grooved in ♀, simple in ♂; sternites VIII-X fused together and hard to distinguish; spiracles distinct and strongly raised on tergites I-VI.

Pyrgoides hamadryas (Stål, 1860)

Material examined: AUSTRALIAN CAPITAL TERRITORY: 3, sex indeterminate, Canberra, reared from adults on *Acacia baileyana* flowers, 13.viii. 1985, C. Reid.



Figs. 14-17. ♀ *Pyrgoides rubiginosa.* **14**, dorsum, left side. **15**, head, anterior. **16**, **17**, apex of venter of ♂ and ♀ respectively. Scale = 1 mm.

Description: similar to *P. rubiginosa*, but less setose. The pupae are almost identical to those of *P.* sp. nr *dryope* (Figs 18-21). *Measurements* (mm.): length 4.8-5.0; head and pronotal width not measured because of distortion. *Head.* Setae: 2 vertex, 1 ocular, 1 upper frons, 2 lateral frons. *Thorax.* Pronotum: 18-19 setae. Mesonotum: 2 setae. Metanotum: 2 setae. Legs: all femora with 3 preapical setae. *Abdomen:* each of tergites I-VI with 2 central, 1 spiracular, setae each side; tergite I with 1 lateral tubercle seta, tergites II-VI with 2 lateral tubercle setae; tergite VII 2-3; tergite VIII 3; tergite IX produced into an elongate triangular process with a single sclerotized apex; sternites as *P. rubiginosa* but sexual characters not distinguished because of poor state of material.

Pyrgoides sp. nr *oenone* (Blackburn, 1899)

Material examined: NEW SOUTH WALES: 1 ♀, 91 km E. Hay, reared from adults and larvae on *Acacia salicina* flowers, 16.v.1986, C. Reid.
Description: similar to *P. hamadryas* except size, and shape of urogomphus. Pronotum with 16-17 setae each side; sternite VIII faintly grooved as in ♀ *P. rubiginosa. Measurements* (mm.): length 3.3; head width 0.8; pronotal width 1.1.

Pyrgoides sp. nr *dryope* (Blackburn, 1900)
(Figs 18-21)

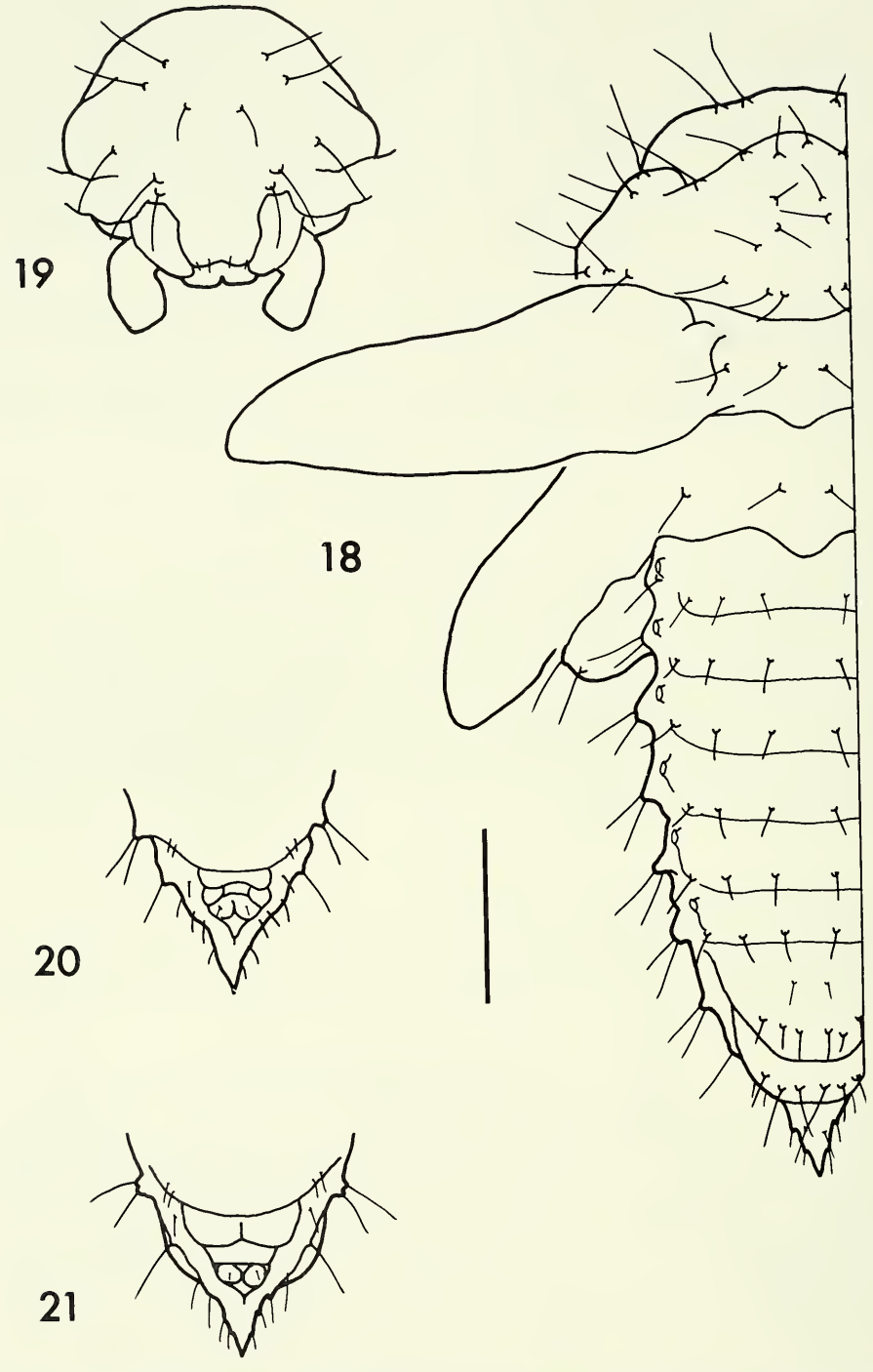
Material examined: AUSTRALIAN CAPITAL TERRITORY: 2♂, 1♀, Canberra, reared from adults on *Acacia baileyana* flowers, 13.viii.1985, C. Reid.
Description: similar to *P. hamadryas*, except in size. *Measurements* (mm.): length 3.2-3.4; head width 0.8; pronotal width 1.3. *Head.* Setae: 2 vertex, 1 ocular, 0-2 lateral frons, 0-1 upper frons. *Thorax.* Pronotum: 17-21 setae, distributed as *P. rubiginosa*. Mesonotum: 2 setae. Metanotum: (1)-2 setae. Legs: all femora with 3 preapical setae. *Abdomen:* setal configuration exactly as in *P. hamadryas* except some lateral tubercles other than tergite I occasionally with 1 seta; sternite VIII of ♀ large with a midline groove, small and simple in ♂; apical sternites fused and difficult to distinguish; spiracles distinct and strongly raised on tergites I-VI.

Trachymela Weise, 1908

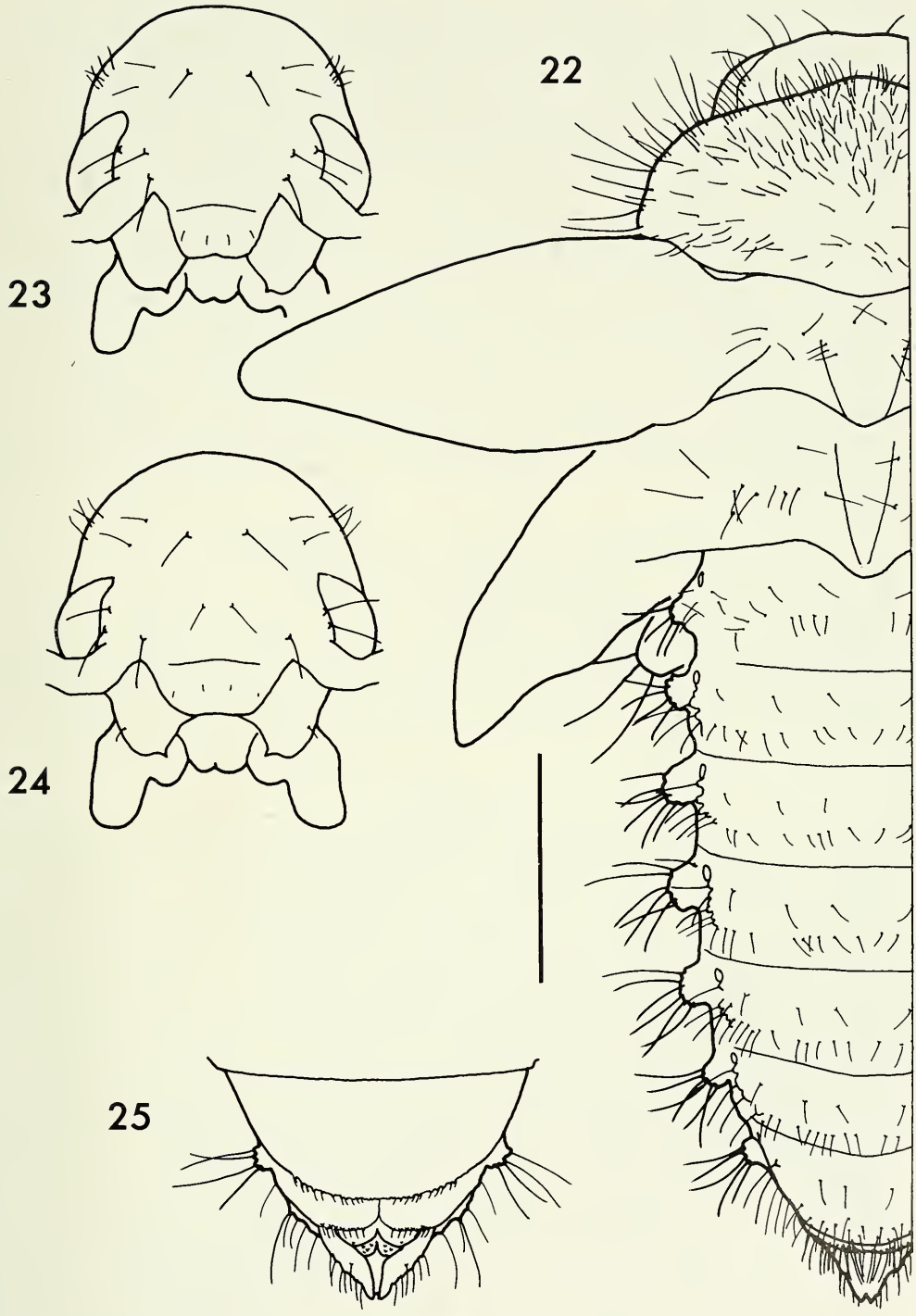
Type species: not designated
Diagnosis: Pupae of *Trachymela* may be distinguished by lack of spiracular tubercles, and presence of moderately setose lateral tubercles, more than 3 upper vertex setae and less than 3 vertex setae.

Trachymela sp. nr *tincticollis* (Blackburn, 1897a)
(Figs 22-25)

Material examined: WESTERN AUSTRALIA, 1♂, 1♀, Kojaneerup, 12k S Bluff Knoll, with larvae and reared adults, ex large secreted tubes (homopteran ?) on stems of *Eucalyptus sargentii*, 9.v.1990, G. P. Hall.
Description: creamy yellow with pale brown setae. *Measurements* (mm.): length, ♂10.2, ♀11.0; head width, ♂2.9, ♀3.0; pronotal width, ♂4.0, ♀3.9. *Head.* Setae: 4-6 upper vertex, 2 vertex, 1-2 ocular, 1 upper frons, 0-1 inner frons, 1-2 lateral frons. Mandibular thecae conspicuously toothed. One specimen with short mandibular setae. *Thorax.* Pronotum: 100-120 setae, scattered but more dense towards front and on disc, and much longer at sides. Mesonotum: 6-9 setae, in roughly two groups, outer 2-3, inner 3-8. Metanotum: 9-13 setae in scattered row, 1-2 setae anteriorly placed. Legs: apex of each femur with 3-4 setae, 3 most frequent (83%). *Abdomen:* tergites I-VI with irregular



Figs. 18-21. ♂ *Pyrgoides* nr. *dryope.* **18**, dorsum, left side. **19**, head, anterior. **20, 21**, apex of venter of ♂ and ♀. Scale = 0.5 mm.



Figs. 22-25. ♀ *Trachymela* sp. nr *tincticollis*. **22**, left side, dorsal. **23-24**, ♀ and ♂ head, anterior. **25**, apex abdomen, ventral. Scale = 2 mm.

transverse row of setae along posterior margin (central and spiracular setae) increasing from 11-12 each side on tergite I, to 16-20 on tergite VI, spiracular setae on raised tubercles; 3-5 small, subsidiary setae on each side of tergites I-VII, anterior to central row; lateral tubercle small with 3-5 setae on tergite I, larger with 4-11 setae on tergites II-VI; tergite VII central and spiracular tubercle setae merged, 17-21 plus 3 anterior subsidiary setae, lateral tubercle reduced, 6-8; tergite VIII without obvious tubercles, largely enclosed within tergite VII, 11-12 plus 3 anterior subsidiary setae; tergite IX projecting from within tergite VIII as a posterio-dorsally directed process with a bifid sclerotized apex; sternites II-VI with 1-2 small setae on posterior margin near lateral tubercle, otherwise glabrous; posterior margin of sternite VII simple, with 12-15 short setae each side; sternite VIII of ♂ with simple posterior margin and 3-5 short spinulose setae each side of margin; sternite VIII of ♀ deeply cleft along midline from base to apex, 8 short spinulose setae each side; venter of tergite IX represented by 2 elongate brown sclerotized lobes with sinuate lateral margins, the lobes contiguous from hemitergites X to their apices, with a few short spinulose setae; sternite IX divided, lobes ovate, separated by their diameter in ♂, lobes transverse, almost contiguous in ♀, tergite X divided, lobes ovate, almost contiguous in both sexes; spiracles dark brown and sclerotized on tergites I-V, small, pale and presumably functionless on tergites VI-VII.

SUBTRIBE DICRANOSTERNINA Weise, 1915

Dicranosterna Motschulsky, 1860

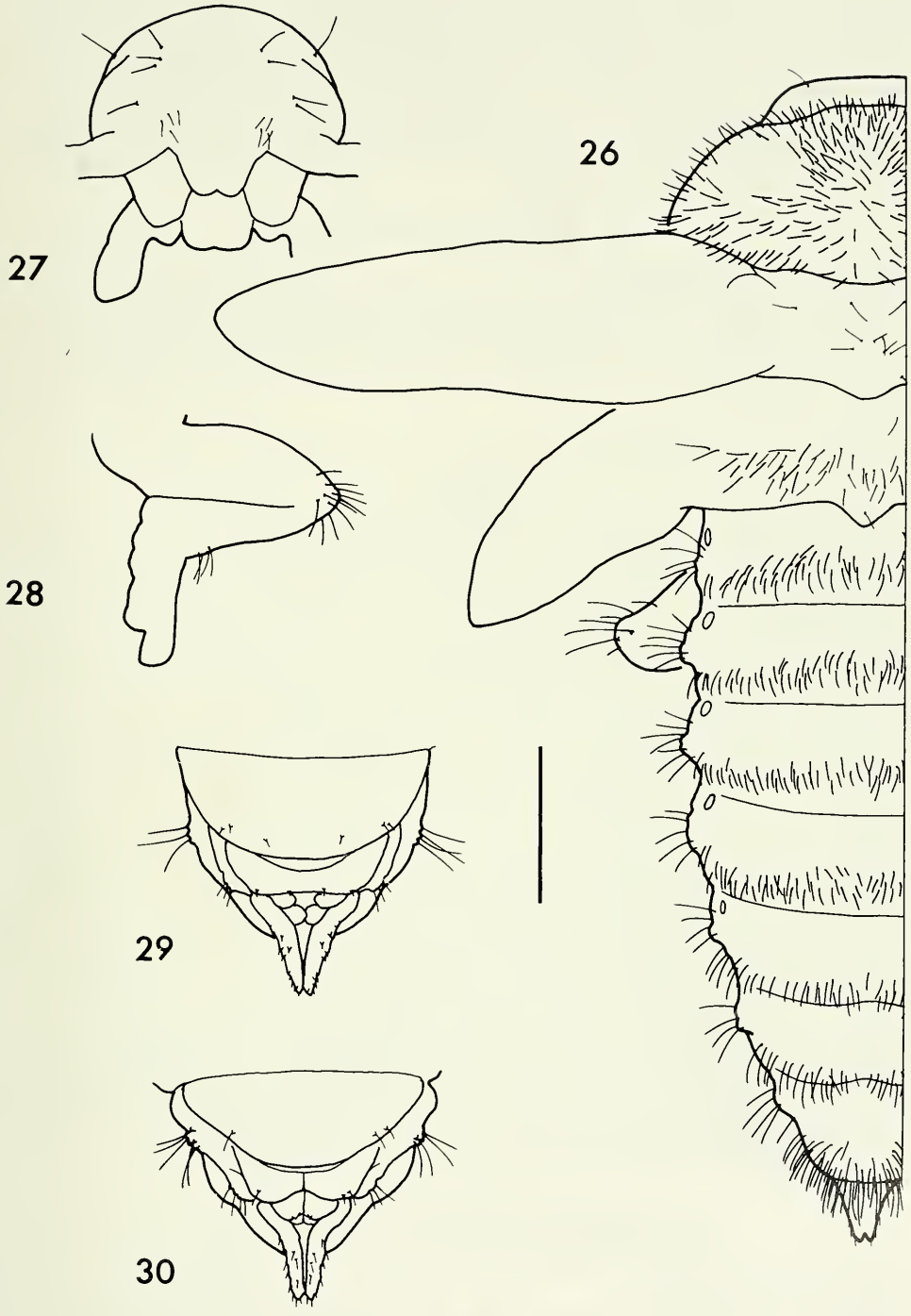
Type species: *Dicranosterna immaculata* Motschulsky, by monotypy

Diagnosis: Pupae of *Dicranosterna* may be distinguished from all others except *Trochalodes* by the combination of dense transverse bands of abdominal setae and very weak or absent lateral tubercles. From *Trochalodes* the pupae are distinguished by having apical tibial setae, less than 3 upper vertical setae and dorsal setae not set on tubercles.

Dicranosterna immaculata Motschulsky, 1860
(Figs 26-30)

Material examined: AUSTRALIAN CAPITAL TERRITORY: 2♂, 5♀, Mount Majura, ex eggs laid by *D. immaculata* on *Acacia mearnsii*, ix.1989, C. Reid; pupated x.1989.

Description: *Measurements* (mm.): length, ♂13.1-14.8, ♀12.1-15.4; head width, ♂2.8, ♀2.8-3.1; pronotal width, ♂ and ♀ 5.2-5.6. *Head.* Setae: 1-2 upper vertex, 2-(4) vertex, 1-(3) ocular, 0-2 upper frons, 3-8 lateral frons, 0-1 inner frons. *Thorax.* Pronotum: 125-145 setae, absent from anterior sides of disc and greatest density in anterior half near midline. Mesonotum: setae in 2 groups, outer 1-2, inner (2)-(8). Metanotum: 50-66 setae in total, in dense transverse row. Legs: each femur with 8-14 preapical setae (11 modal, 29%), fore and mid tibia with 1-2 preapical setae and hind tibia with 1-3 preapical setae. *Abdomen:* tergites I-VI with dense transverse row of setae along posterior margin (central setae) of similar density from tergite I (22-40 each side) to tergite VI (27-36); with occasional small, single setae on each side of tergites I-VII, anterior to central row; tergites I-VI without globular prominences, lateral tubercles small and spiracular setae on weak tubercle separate from central setae; (2)-(8) spiracular setae on tergite I, 4-(9) on tergite VI; 4-(7) lateral tubercle setae on tergite I, (5)-8 setae on tergite VI; tergite VII with 24-36 central and 4-6 spiracular setae; tergite VIII largely enclosed within tergite VII, with apical band of 36-56 setae; tergite IX projecting from within tergite VIII as a blunt posterio-dorsally directed process with a bifid weakly sclerotized apex; sternites II-V glabrous, VI with 2 small lateral apical setae; posterior margin of



Figs. 26-30. ♂ *Dicranosterna immaculata.* **26**, left side, dorsal. **27**, head, anterior. **28**, hind leg. **29-30**, ♂ and ♀ apex abdomen, ventral. Scale = 2 mm.

sternite VII simple, evenly rounded with 2-5 small apical setae set on tubercles; posterior margin of sternite VIII of ♂ slightly concave, with 3-4 setae on tubercles each side; sternite VIII of ♀ completely divided along midline from base to apex, with 2-4 setae each side; venter of tergite IX represented by 2 apically contiguous lobes with sinuate lateral margins with many short setae; sternite IX divided, lobes ovate, separated by their diameter in ♂, contiguous in ♀; tergite X divided, lobes ovate, contiguous in both sexes; spiracles distinct, dark brown and sclerotized, slightly raised, on tergites I-V, not visible on tergite VI.

Trochalodes Weise, 1901

Type species: not designated.
Diagnosis: Pupae of *Trochalodes* may be distinguished from all others except *Dicranosterna* by the combination of dense transverse bands of abdominal setae and very weak or absent lateral tubercles. From *Dicranosterna* the pupae are distinguished by having more than 3 upper vertical setae and dorsal setae set on tubercles and lacking apical tibial setae.

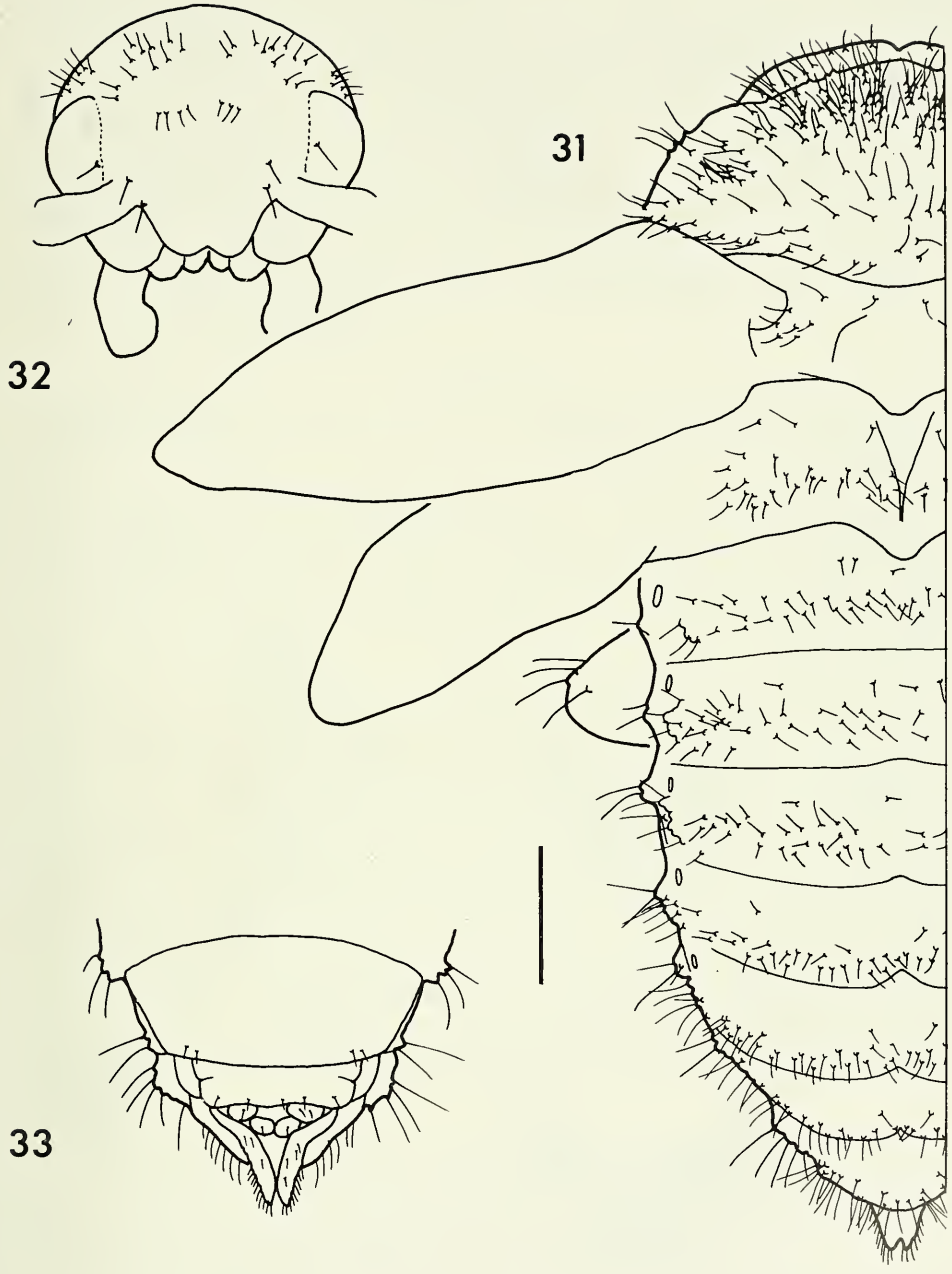
Trochalodes sp. nr *hemisphaerica* (Chapuis, 1877)
(Figs 31-33)

Material examined: WESTERN AUSTRALIA: 3♂, Cervantes, ex larvae with adults on *Acacia rostellifera*, 20-23.viii.1987, C. Reid; pupated 1-3.ix.1987.
Description. *Measurements* (mm.): length, 8.6-8.7; head width, 2.1-2.3; pronotal width, 3.5-3.7. *Head.* Setae: 6-9 upper vertex, 5-7 vertex, 1-2 ocular, 2-4 upper frons, 2-3 lateral frons. *Thorax.* Pronotum: 60-65 scattered setae set on prominent tubercles, greatest density in anterior half, near midline. Mesonotum: setae in 2 groups, outer 7-16, inner 0-2. Metanotum: 21-31 setae, scattered in transverse row, with 2 or 3 basal setae. Legs: each femur with 2-6 preapical setae, 4 most frequent (56%). *Abdomen:* tergites IV-VI emarginate at apex; tergites I-VI with irregular transverse row of setae along posterior margin (central setae and spiracular setae) increasing from 17-22 each side on tergite I, to 22-36 on tergite VI and 1-6 small, subsidiary setae on each side of tergites I-VIII, anterior to central row; tergites I-VI without globular prominences, but slightly tuberculate at sides; setae of spiracular area not distinguishable from central setae; lateral tubercles small, with 1-2 setae on tergite I, 2-7 setae on tergites II-VI; tergite VII central and spiracular tubercle setae merged, 34-42, lateral tubercle, 1-3; tergite VIII largely enclosed within tergite VII, 17-23; tergite IX projecting from within tergite VIII as a blunt posterio-dorsally directed process with a bifid, weakly sclerotized, apex; sternites II-VI glabrous; posterior margin of sternite VII simple, with 1-2 small setae laterally; sternite VIII simple, with 1-2 small setae each side of margin; venter of tergite IX represented by 2 weakly sclerotized lobes with straight lateral margins, the lobes contiguous at their apices, with a few short setae; sternite IX divided, lobes ovate, separated by their diameter; tergite X divided, lobes ovate, contiguous; spiracles distinct, dark brown and sclerotized on tergites I-V, not visible on tergite VI.

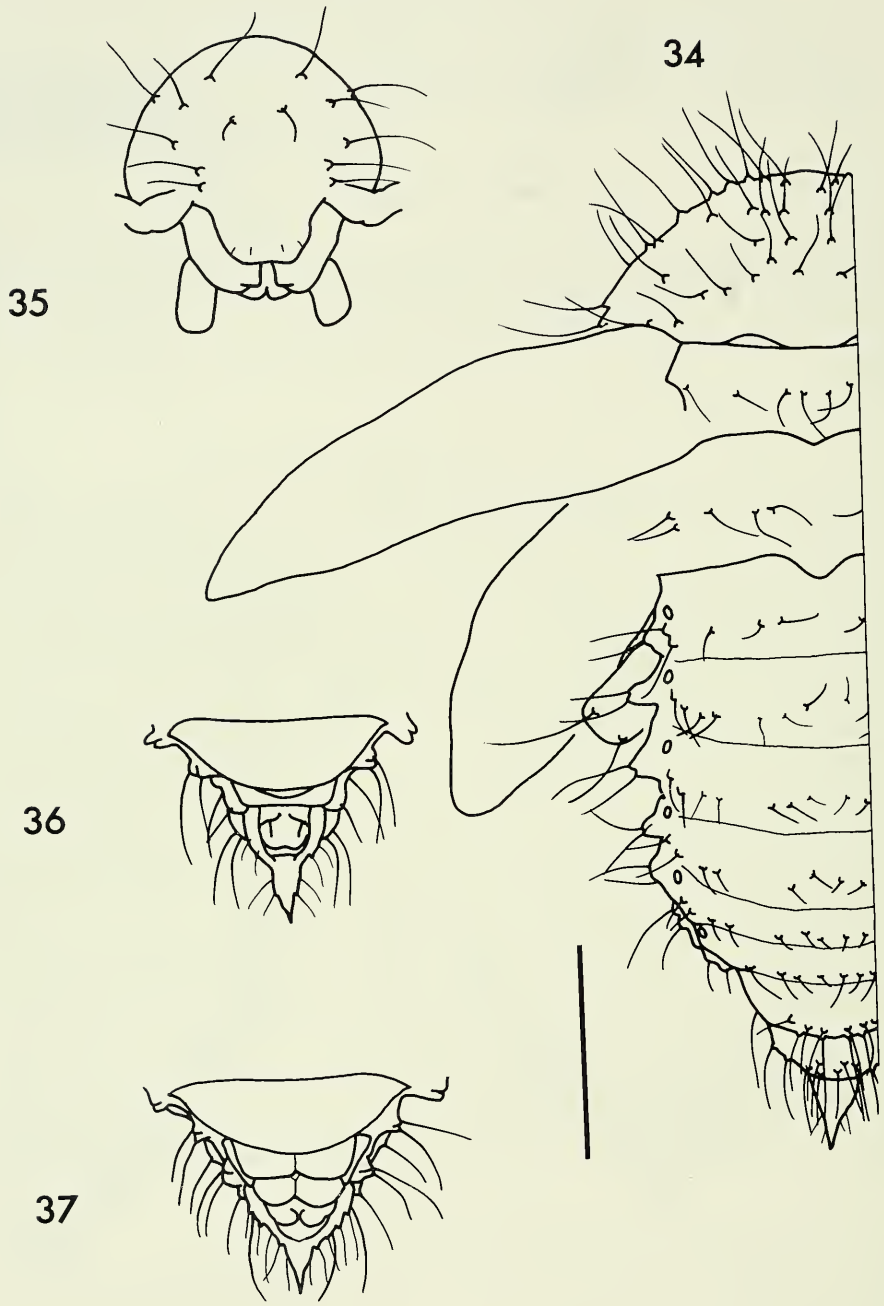
SUBTRIBE UNKNOWN

Novacastria Selman, in Selman and Lowman, 1983

Type species: *Novacastria nothofagi* Selman, in Selman and Lowman, 1983, by original designation and monotypy
Diagnosis: The pupae of *Novacastria* may be distinguished by the combination of ventrally fused urogomphi with a single pointed apex, 1-2 upper vertical setae, more than 4 metanotal setae and weakly developed lateral tubercles with 1-3 setae.



Figs. 31-33. ♂ *Trochalodes* nr *hemisphaerica.* **31**, left side, dorsal. **32**, head, anterior. **33**, apex abdomen, ventral. Scale = 1 mm.



Figs. 34-37. ♂ *Novacastria nothofagi.* **34**, dorsum, left side. **35**, head, anterior. **36-37**, apex of venter of ♂ and ♀. Scale = 1 mm.

Novacastria nothofagi Selman, in Selman and Lowman, 1983
(Figs 34-37)

Material examined: NEW SOUTH WALES: 2♂, 3♀, New England National Park, ix.1980, M. Lowman.

Description: similar to *P. rubiginosa*, but broader and urogomphus simple. *Measurements* (mm.): length 4.2-4.4; head width 1.2-1.3; pronotal width 1.8-2.1. *Head.* Setae: 1-(2) upper vertex, 2 vertex, 1 ocular, 2 lateral frons, (0)-1 upper frons. *Thorax.* Pronotum: 25-31 setae, distributed as *P. rubiginosa*. Mesonotum: 3-5 setae. Metanotum: 5-7 setae. Legs: all femora with 3 preapical setae. *Abdomen:* each of tergites I-VI with (2)-5 central setae each side, without subsidiaries, 1-2 spiracular setae, and 2 lateral tubercle setae (frequently only 1 on tergite I); tergite VII with 5-6 marginal setae; tergite VIII with 4-5 setae; tergite IX produced as an elongate triangular process with a single sclerotized apex; sternite VIII of ♀ large with a midline groove, of ♂ small and simple; spiracles distinct and slightly raised on tergites I-VI.

Discussion

Kimoto (1962a) discovered a correlation between pupal and larval characters of Japanese Chrysomelinae and used this in a new classification of the subfamily. He divided the subfamily into two by the presence or absence of a row of eversible glands in the larvae. Each subdivision was further divided according to characteristics of both larvae and pupae. His pupal types were defined on the basis of urogomphal structure. Only 3 of his genus-groups (all of which belonged to the assemblage of larvae without lateral glands) had pupae with urogomphi on tergite IX: *Chrysolina*-group (Doryphorina + Chrysolinina *sensu* Daccordi, 1982; single projection), *Gonioctena*-group (Gonioctenina + Chrysomelina partim, *sensu* Daccordi, 1982; pair of free-standing projections), and *Potaninia*-group (Entomoscelina, *sensu* Daccordi, 1982; pair bent inwards at the base). The only paropsine pupa to have been associated with this classification belongs to *Paropsides* which Takizawa (1976) placed in the *Paropsis*-group (Paropsina, *sensu* Daccordi, 1982), near the *Gonioctena*-group, using larval characters. Pupae of these 2 groups were distinguished by him by the possession of a single urogomphus in the *Paropsis*-group. However the pupa of *Paropsides* was first described and illustrated by Ohno (1958) who clearly showed that the apex of tergite IX consisted of a pair of contiguous processes. Ohno considered the similarities of the larva and pupa of *Paropsides* to those of *Gonioctena* Chevrolat (= *Phytodecta* Kirby) to be sufficient to negate their placement in separate tribes on the single criterion of elytral epipleuron shape (Weise, 1915).

The only descriptions of Australian paropsine pupae are very brief. Cumpston (1939) noted that the pupa of *Paropsis atomaria* (= *reticulata* aucct.) had a 'ventral bilobed dark brown shield', presumably referring to segment IX. This structure was also recorded for *P. obsoleta* but was not mentioned in her descriptions (of colour) of pupae of *Paropsisterna* Motschulsky and *Chrysophtharta* Weise.

Discrimination of the subtribes Dicranosternina and Paropsina

The combination of large size, feeble development of the lateral tubercles, dense transverse bands of setae and adjacent but apically separated urogomphi distinguishes the pupae of Dicranosternina from Paropsina and other Chrysomelinae. The similarity of the pupa of *Dicranosterna* to *Trochalodes* is not surprising because these two genera are poorly differentiated as adults. They may be synonymous, although from the material to hand they are also distinguishable as larvae, and it is possible that the presence of tibial setae, unique in Chrysomelinae, is a generic characteristic of *Dicranosterna*.

The subtribe Paropsina is not well characterized as a monophyletic group because it is morphologically diverse. For example, the urogomphi are either completely fused or

adjacent but ventrally free and separated at tips. The lateral tubercles are prominent, but variably setose. The distribution of setae is variable. Some pupae are similar to those of Dicranosternina (for example in urogomphi), but without an outgroup for comparison it is not known if this similarity is phylogenetically significant. The pupae of Paropsina may be divided into 2 distinct groups, and these are considered further below.

Discrimination of groups of genera in Paropsina

The pupae of the genera of Paropsina considered here appear to show a sequence of progressive setal diversity, from the few, non-spinulose, setae of *Pyrgoides hamadryas* and allies to the numerous secondary, and in the anal region, spinulose, setae of *Paropsisterna*. This sequence is to some extent correlated with both size and development of lateral tubercles, and is negatively correlated with fusion of the 2 urogomphi. However, setal development and fusion of urogomphi are quite different in the similar-sized pupae of *Pyrgoides rubiginosa* and *Paropsides* and this suggests that these attributes are of phylogenetic significance. The primary division of the Paropsina genera may therefore be pupae with: (a) simple setal pattern, no spinulose setae on apical sternites and fused urogomphi (species of *Pyrgoides*); or, (b) numerous secondary setae, spinulose setae on apical sternites and a pair of adjacent but distinct urogomphi (*Chrysophtharta*, *Paropsides*, *Paropsis*, *Paropsisterna* and *Trachymela*).

Pyrgoides species

Two forms of pupa are distinguishable: larger, with incompletely fused urogomphi and a few secondary setae (*P. rubiginosa*), or smaller, with completely fused, apically pointed, urogomphi and simple setal pattern (*P. hamadryas* and allies). These differences may be correlated with size.

Chrysophtharta, Paropsides, Paropsis, Paropsisterna and *Trachyrnela*

In this group, there is a range of variation from the relatively less setose, laterally weakly tuberculate, small pupae of *Paropsides*, to the densely setose, strongly tuberculate, large pupae of *Paropsisterna*. The pupae of *Paropsis* and *Paropsisterna* are distinguished by shared possession of strongly developed spiracular tubercles, patches of small setae at the sides of sternite VI, and the strongly sclerotized apex of sternite VII. The pupae of *Chrysophtharta* and *Trachymela* are morphologically intermediate between *Paropsides* and *Paropsis*.

The features characteristic of this group of genera are also present in *Paropsides duodecimpustulata* Gebler (Ohno 1958, the pupal description appears to be of a ♂), the Asian type species of *Paropsides*. This species differs from its Australian congener by having more numerous setae on the vertex, lateral tubercles and femoral apices, and therefore appears more similar to Australian genera other than the species currently placed in *Paropsides*.

Position of Novacastria

Pupae of *Pyrgoides* and *Novacastria* are similar to each other and are characterized by: small size; few setae, on raised tubercles, including only 2 pairs of vertical setae and less than 6 pairs of central abdominal tergite setae; spiracular tubercles absent and lateral tubercles weakly developed with 3 or less setae; posterior margins of sternites VII and VIII simple, without specialized setae or ridges; abdominal segments VIII-X fused, difficult to distinguish; tergite IX produced into a single process, sclerotized only at tip, sometimes bifid; sexual dimorphism poorly indicated, sternite VIII with a medial groove in ♀ but simple and apparently smaller in ♂.

The pupa of *N. nothofagi* differs from those of all *Pyrgoides* spp. by having upper vertical setae and more metanotal setae. The pupa of *P. rubiginosa* may be distinguished from those of other *Pyrgoides* spp. and *Novacastria* by the bifid urogomphus.

Possession of paired, basally fused urogomphi was regarded by Selman and Lowman (1983) as characteristic of paropsine pupae (e.g. *Paropsisterna*) in contrast to a single urogomphus (*Novacastria*) or a pair of separated urogomphi (*Calomela* Hope). These authors placed *Calomela* in the *Chrysolina*-group and *Novacastria* in the *Gonioctena*-group of Kimoto, although the pupal urogomphi suggest the reverse. They considered the paropsines to be intermediate between these two groups. *Novacastria* was not considered to be a paropsine because of the single pupal urogomphus, which is now shown to be present in *Pyrgoides* species, and the unrecessed epipleurae. In *Novacastria* the epipleurae slope upwards slightly, especially by the humeri. In *P. rubiginosa* and related species the epipleurae slope upwards at no more than 45°. This single character of the epipleuron is the only criterion for the separation of Gonioctenini (*sensu* Weise, 1915) and Paropsini, and was implicitly rejected by Ohno (1958). The larva (Selman and Lowman, 1983), adult and pupa of *N. nothofagi* are similar to various paropsine species. These similarities suggest that the genus *Novacastria* may be better placed in the subtribe Paropsina.

Pupal Characters and Phylogeny

Structure of the urogomphi of tergite IX is a key element in the subdivision of the Chrysomelinae using pupal characters. A pair of separate urogomphi on tergite IX appears to be the plesiomorphic state within the Chrysomeloidea, with wide occurrence in both Cerambycidae (Duffy, 1952) and Chrysomelidae (eg. Takizawa, 1972; LeSage, 1984; Reid, 1991). Urogomphi are absent from the 'glanduliferous' Chrysomelinae (Kimoto, 1962a), but the pupa of the plesiomorphic genus *Timarcha* Latreille (not considered by Kimoto) has a single urogomphus with a bifid apex (Paterson, 1931). The single (ie. completely fused pair) urogomphus of *Pyrgoides* spp. and *N. nothofagi* may not be homologous with the single urogomphus of the *Chrysolina*-subgroup of genera, because in the latter, at least in *Leptinotarsa* Stål (Doryphorina, *sensu* Daccordi, 1982; specimens seen in ANIC), the whole structure is strongly sclerotized and ridged at the base. The form of urogomphi with fusion of the processes dorsally but separation ventrally, as described here for Paropsina and Dicranosternina, appears to be unique to these subtribes.

The toothed and setose mandibular thecae of the pupa of *Johannica* Blackburn was recently considered to be unique to that genus in the Chrysomelinae (Reid, 1991). The mandibular theca is conspicuously toothed in *Chrysophtharta*, *Paropsis* and *Trachymela* and in other genera the tooth is present but less distinct. One pupa of *Trachymela* had a mandibular seta. These possibly plesiomorphic characters are evidently widespread in Chrysomelinae and may have little phylogenetic importance.

The presence of lateral tubercles is widespread in the Chrysomelidae (Paterson, 1931), although absent from the 'glanduliferous' chrysomelines (Kimoto, 1962a). The condyliform type is only known from Paropsina in the Chrysomelidae. Spiracular tubercles are rarely indicated in descriptions but are apparently present in *Gonioctena* (Takizawa, 1976) and *Chrysolina* (Kimoto, 1962b).

The number of apical femoral setae is variable in the sample of genera described here, although each species generally has 3 or less or 4 or more femoral setae. The plesiomorphic number of setae is probably 3, as this occurs widely in Chrysomelidae and Curculionoidea (Takizawa, 1972; Costa, Vanin and Casari-Chen, 1988). However, the variation between individual femora is so high that this character has only limited

use in phylogenetic analyses. The derived state of more than 3 femoral setae is found in all genera except *Pyrgoides*, *Paropsides* and *Novacastria*.

The large pupae of the 'non-glanduliferous' genera of Japan (Kimoto, 1962b) are mostly very setose, with setose abdominal tubercles, similar to *Paropsis*. However pupae of the 'glanduliferous' genera (Kimoto, 1962a) always have few setae, similar to *Pyrgoides* and *Novacastria*, despite great variation in size. This reduced setal pattern is widespread in the Chrysomelidae generally (Paterson, 1931; Takizawa, 1972; LeSage, 1984), and may represent the plesiomorphic condition for the paropsines, but it is difficult to be sure that the patterns are homologous.

Pupal sexual dimorphism has been described for pupae of *Paropsis* (Reid and Ohmart, 1989), *Colaphellus* Weise (Brovdii, 1977) and *Johannica* (Reid, 1991) in the Chrysomelinae, and for Cerambycidae (Duffy, 1952). In the three latter examples the female is characterized by sternite IX being represented by two prominent tubercles. The sexually dimorphic structure of the abdominal apex described above for the pupae of Paropsina and Dicranosternina appears to be restricted to these groups.

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